A MACROECONOMIC MODEL FOR DETERMINING YIELDS ON MUNICIPAL BOND MARKET FOR STATES UNDER U.S. MONETARY UNION

by

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A dissertation submitted to the faculty of
The University of Utah
in partial fulfillment of the requirements for the degree of

Doctor of Philosophy

Department of Economics

The University of Utah

December 2015

The University of Utah Graduate School

STATEMENT OF DISSERTATION APPROVAL

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ABSTRACT

This dissertation develops a macroeconomic model of state borrowing costs for the U.S. monetary union that is founded on the real business cycle theory. The model develops supply and demand side equations for the U.S. monetary union. It shows that the spread between the borrowing cost of a state and the risk free rate is function of default probability (PD) of the state government and loss given default (LGD) for investors. In this macroeconomic model framework, the probability of default is determined simultaneously by the intertemporal utility maximization behaviors of investors (consumers) and the ability of a state government to maintain its budget constraints. This model also empirically identifies exogenous shocks that influence the default probability and the borrowings cost of a state in the U.S. monetary union. After analyzing 17,400 newly issued general obligation bonds and controlling for the variation in bond characteristics, empirical analysis shows that exogenous shocks emerge from state fiscal institutions, political institutions, government budgetary decisions, public debt stock, pension funding, and labor market conditions; all these variables impact the yield spread between a state borrowings cost and the risk free rate.

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ACKNOWLEDGMENTS

Firstly, I would like to thank and to express my respect and gratitude to my supervisor Professor Lance Girton, who worked with me continuously for the last two years and guided my research. His mentoring immensely helped me to successfully finish this PhD dissertation.

Besides my advisor, I am also grateful to other supervisory committee members, particularly to Professor David M. Kiefer, who read my manuscripts with great patience and enriched my research with insightful comments.

Last but not the least, I like to thank my family: my wife and my mother for supporting me emotionally throughout writing this thesis.

CHAPTER 1

INTRODUCTION AND SUMMARY

For a long time now, researchers have been reporting on the unsustainable level of states′ public pension funding, while tax bases are stagnant and expenditures are ballooning for state health care and welfare programs. During the past decades, state governments have grown by providing public goods, such as police protection, education, highway building and maintenance, welfare programs, hospitals, and health care, etc. However, revenue for state governments, which comes mostly from taxation and fees, cannot keep pace with increased spending; thus most states have been issuing municipal bonds to meet budget deficits. In 2013, local and state government borrowed $334.9 billion and the total municipal debt rose to $3.67 trillion. Thirty-nine percent of this substantial debt is owed by state governments, the rest is owed by local governments. The size of the municipal bond markets has increased to three trillions dollars since the year 2010, and for the first time since the Great Depression, both investors and regulators are concerned that several U.S. states might go bankrupt and/or need massive taxpayer funded bail outs (Nadler & Hong, 2010). Public anxieties about the state governments′ debt have reached a peak, and investors and tax payers alike are worried about the capacity of municipal governments to service the existing debts, as well as the likelihood of future tax hikes. Investors′ concern about the ballooning state debt and the worsening of states′ fiscal situations may very soon be reflected in the municipal bond markets, where an increasing yield for all types of bonds across the states is becoming more and more probable. In the present municipal bond market, a jump of a couple of percentage points in municipal bond yields would transfer a large sum of money from tax payers to investors. This study aims to shed light on the determinants of state government borrowing costs, i.e., the yields of municipal bonds.

At present, a number of studies provide theoretical arguments and empirical supports for the predominant factors that influence the borrowing costs for states. In general, most of this research can be grouped into two categories: (1) research that emphasizes the general economic variables, influencing states and (2) research that highlights state fiscal institutions that govern budget rules. Economic variables, which can have a direct or indirect impact on states′ revenue and expenditure, i.e., the capacity to service debts, significantly influence municipal bond yields. Since the population characteristics, industrial base, natural resources, property values, etc. of states vary, the capacity to service debt also varies from state to state, as does the borrowing cost. Liu and Thakor (1984), Goldstein and Woglom (1991), and Bayoumi, Goldstein, and Woglom (1995) estimate the impact of state-specific economic variables on the yields of state municipal bonds after controlling for the credit ratings of states. They identify state economic variables, such as net debt, debt per capita, state tax rate on interest income from municipal bonds, unemployment, and median home value that varies in municipal borrowing costs. One particularly important argument emerges from the research: the market disciplines those states that run excess fiscal deficit and accumulate debt by demanding higher borrowing costs. This market disciplinary behavior may provide incentives to state governments to correct their fiscal behavior.

The literature also emphasizes the impact of fiscal institutions on borrowing costs, arguing that although every state operates in a similar legal and fiscal environment, the fiscal behaviors and budgeting rules differ substantially from state to state. The difference can be attributed to substantial variation in states′ fiscal institutions. These institutions include, but are not limited to, the constitutional and legislative requirements for balanced budgets, tax and expenditure limits, limits on issuing general obligation debt, etc. These antideficit fiscal institutions can have two effects. First, these institutions can reduce the primary deficit by limiting incentives for fiscal policymakers for spending more than the tax revenue and increasing government size by extracting more and more revenue from the public. Second, these fiscal institutions also reduce borrowing costs for states because the bond market demands a lower default risk premium for states with better fiscal management (Poterba & Rueben, 1999). A large body of literature substantiates the effect of fiscal institutions on government size and fiscal deficit, as well as the amount of states′ borrowing and their borrowing cost. Bohn and Inman (1996), Poterba (1994), and Primo (2003) report that states with strict balanced budget rules also have lower per capita spending and lower budget deficits than those states that do not. Ruben (1996) reports that states with tax and expenditure limits, also have lower spending, equivalent to a fraction of state income. Markets often price these antideficit fiscal institutions by lowering the borrowing costs of the states that support them. Goldstein and Woglom (1991), Bayoumi, Goldstein, and Woglom (1995), and Poterba and Rueben (1999) report a significant negative relationship between the antideficit fiscal institutions and states′ borrowing costs. A shortcoming of their studies is that they do not analyze market transaction data of states′ borrowing costs. They use survey data collected by Chubb Corporation on dealers′ expected yields for general obligation (GO) bonds. Craig and Kenneth (2005) overcome this shortcoming by estimating the relationship between antideficit fiscal institutions, such as debt limit, balanced budget requirements, tax and expenditure limits, credit ratings, and the states′ borrowing costs, and analyzing market data of general obligation bond yields. They find debt limit, balanced budget requirements, and expenditure limits have a significant impacts on states′ credit ratings, but do not have any impact on the states′ borrowing costs. Only tax (revenue) limits significantly impact the borrowing costs for the states.

The analysis conducted in this paper differs from prior studies in several important ways. First, this study develops a macroeconomic model that determines the borrowing costs of U.S. states inside a monetary union. Second, it analyzes a larger data base, specifically 17,400 new issues of general obligation (GO) bonds that were offered to the market by 37 states between the years 2001 and 2011. The yields of these GO bonds reflect a wider market perception of the default risk to the states. Third, this study examines a larger set of economic, political institutions and fiscal institutions variables, after controlling for bond characteristics that are found to influence the probability of default of a borrower state and, therefore, increase the borrowing cost.

The macroeconomic model of state borrowing costs in this study is founded on the real business cycle theory and developed supply and demand side equations for the U.S. monetary union. This model shows that spread between the borrowing cost of a state and the risk-free rate is a function of default probability (PD) of the state government and loss given default (LGD) for investors. In this macroeconomic model framework, the probability of default is determined simultaneously by the intertemporal utility maximization behaviors of investors (consumers) and the ability of a state government to maintain its budget constraints. This model identifies economywide exogenous shocks that disturb the dynamic equilibrium through endogenous transmission mechanisms, and influence the debt servicing capacity (the default probability) of a state. Since these shocks create nondiversifiable risks at the portfolio level, investors price these shocks, and the borrowing costs of U.S. states changes. After analyzing 17,400 newly issued general obligation bonds and controlling for variation in bond characteristics, the empirical work estimates that exogenous shocks that emerge from state fiscal institutions, political institutions, government budgetary decisions, public debt stock, pension funding, and business cycles have significant statistical power to explain the yield spread between a state borrowing cost and its risk-free interest rate.

Major implications of findings of this study are: states in U.S. monetary union can lower their borrowing costs if they institute antideficit fiscal rules, and they are governed by fiscally responsible political parties. The municipal bond market disciplines those states that are fiscally profligate and accumulate debt, with higher borrowing costs. Exogenous macroeconomic shocks are nondiversifiable in a portfolio level and the municipal bond market compensates investors for accepting these risks in their portfolios.

Organization of this Ph.D dissertation is as follows: Chapter 2 introduces the municipal bond market and summarizes the existing literature, Chapter 3 develops the macroeconomic model of state borrowing costs under U.S. monetary union, Chapter 4 and 5 estimate the model empirically and explain the results.

CHAPTER 2

LITERATURE REVIEW

A municipal bond or security is a promise by a local or state government or state agency to repay lenders the principal amount of borrowed money as well as any interest accrued after a fixed period. The maturities of municipal bonds vary from 1 to 30 years, but some have maturities lasting up to 40 and even 100 years. Municipal securities with maturities of more than 13 months are generally referred to as municipal bonds, and those with maturities of less than 13 month are called anticipation notes or commercial paper.

Both long- and short-term municipal securities are categorized into two major groups: general obligation (GO) and revenue bonds. GO bonds are pledged by the full faith and credit of a local or state government, which implies that all available local and state governments resources (except any revenue already dedicated to other purposes) will be used to pay the debtor both principal and interest. Revenue bonds are issued by a local or state government to finance diverse capital development projects and are generally backed by income from those particular projects. Sometimes, a revenue bond issued to finance specific capital projects is also backed by an unlimited general obligation pledge. This type of bond is called a double-barreled Bond. Outside these two types of municipal bonds, there are also specific tax bonds and moral obligation bonds (*The Fundamentals of Municipal Bonds*, 6^{th} edition).

Interest income from most of the municipal bonds is exempted from federal taxation. On some occasions, interest income from the municipal bonds is also local and state tax exempt. Thus, these bonds are called tax exempt bonds. There are some municipal bonds, created by the American Recovery and Reinvestment ACT of 2009, that are taxable and are subsidized by the federal government. These bonds are subject to federal, state, and local government taxes. They are called taxable municipal bonds. One example of this type of bond is the Build America bond (*The Fundamentals of Municipal Bonds*, 6^{th} edition).

Due to their tax exempt status, municipal bonds are an attractive investment option for high net worth individuals and institutions with higher marginal income tax rates. Among the institutional investors, commercial banks, fire, and causality and life insurance companies are deemed worthy of such status (Rosenbloom, 1976). Since insurance companies are minor participants in the municipal bond market, the commercial banks are the principal institutional investors and generate the bulk of the demand for municipal bonds (Kimbal, 1977). Commercial banks not only use municipal bonds′ tax exempt status as a shield against higher marginal tax rate, but also invest in municipal bonds, particularly in short- to intermediate-term bonds, as part of their liquidity management strategy (Rosenbloom, 1976).

New issues of municipal securities are first sold in the primary market. Issuers sell new issues either by negotiated or by competitive bid methods. In a negotiated sale, an issuer finds an underwriter to manage the sales. The underwriter can be a single dealer or a group of dealers. Both the issuer and the underwriter negotiate the terms of offering, such as price, maturity, insurance, etc. In a competitive sale, an issuer invites sealed bids from competing underwriters, and the issuer chooses the underwriter who offers the most favorable terms. The terms of offering, such as price, maturity, etc. are proposed by competing underwriters.

Underwriters who buy new issues from issuers in primary market usually do not hold these securities until maturity, sell them to investors in the secondary market. After that, investors regularly buy and sell municipal securities among themselves in the secondary market. In the secondary market, trading of municipal securities does not take place in an organized exchange. It takes place in an over-the-counter market that is dominated by dealers.

2.1 Existing Municipal Bond Pricing Models

When an investor earns interest income from a municipal bond issued by a local or state government, this income is exempted from federal, and, on some occasions, state income taxes. For a progressive tax structure, the value of the tax-exemption feature increases as investors′ taxable income qualifies them for a higher-income tax group. Merton H. Miller (1976) first argued that two bonds with similar maturities and credit ratings are identical except for the fact that one is taxable by the federal government and the other is federally tax exempt; thus, an investor will not distinguish between the two if the yield on the tax-exempt bond (R_M) is equal to the after-tax yield on the taxable bond (R_T):

$$R_M(n) = (1-t)R_T(n) \tag{2.1}$$

't' is the federal tax rate on taxable bond income in equation (2.1). In equilibrium,'t' is determined by the income tax rate of the marginal buyer of a tax-exempt municipal bond. There are two contrasting theories regarding what determines the income tax rate of the marginal buyer of a tax-exempt municipal bond.

Merton H. Miller (1976) suggests that the tax rate of the marginal bond holder would be equal to the corporate tax rates. He argues that the supply of taxable bonds is responsive to the relative yields on taxable (corporate) and tax-exempt (municipal) bonds. If the corporate income tax rate is higher than personal marginal income tax on interest income from the taxable corporate bond, then corporations can gain from leverage by supplying taxable corporate bonds. If, however, the corporate income tax rate is lower than personal marginal income tax on interest income from the taxable corporate bond, corporations lose from leverage. Miller (1976) reasons that since personal income tax is progressive but corporate income tax is flat, then firms supply taxable corporate debt to the point where the tax advantage from leverage is exhausted, and in equilibrium corporate income tax rate is equal to the personal marginal income tax rate of taxable corporate bond buyers. Thus, in equilibrium, the spread between taxable and tax-exempt bonds of similar risks should be equal to the corporate tax rate. Fama (1977) further argues that corporations can reap arbitrage profit if the spread between taxable and tax-exempt bonds is more than the corporate tax rate. They can do so by purchasing tax-exempt bonds and issuing debt with tax deductible interest income, using tax-exempt bonds as collateral to hold the risk constant. Banks, in particular, can be engaged in this arbitrage activity since they are allowed to both purchase municipal bonds and issue taxable debt for business purposes (Heaton, 1986).

The contrasting theory argues that the equilibrium marginal tax rate is determined by the supply of tax-exempt bonds from local and state governments, and the demand of institutional investors, mainly commercial banks, property insurance companies, and individual investors. The supply of municipal bonds is primarily determined by the financial need of state and local governments to undertake capital investments or to balance their budgets, inelastic to municipal bond yield. So, equilibrium marginal income tax rate of municipal bond investors depends on the demand of the institutional investors and individual investors (Hendershott & Kotch, 1977; Kimbal, 1977). Since property insurance companies are minor participants in the municipal bond market, the demand for municipal bonds mainly depends on the participation of commercial banks (Fortune, 1973; Kimbal, 1977). Now, the demand for municipal bonds from commercial banks largely depends on the level of their income, i.e., the amounts of income commercial banks need to shield from taxation. When the income of commercial banks is higher, the demand for municipal bonds is also higher. Thus, yields on municipal bonds fall and the marginal tax rises. On the other hand, when the income of commercial banks falls, the demand for municipal bonds by institutional investors also falls. Thus, municipal bonds must offer higher yields to attract investors from the lower income tax group, and the marginal tax rate falls (Trzcinka, 1982). According to this theory, the Miller (1976) hypothesis is true as a special case: the income tax rate of marginal investors is equal to the corporate tax rate only if all municipal bonds are purchased by institutional investors such as banks, quite a rare situation. Thus, the income tax rate of marginal buyers of municipal bonds varies according to the level of commercial banks′ participation (Trzcinka, 1982).

Trzcinka (1982) examines these two contrasting theories and concludes that if risk is properly accounted for, then the marginal tax rate is equivalent to the corporate tax rate. He argues that Miller′s (1976) hypothesis apparently does not hold because tax-exempt (municipals bonds) bonds are riskier than taxable bonds (corporate bonds) of the same credit ratings. When credit rating agencies calculate ratings, they focus only on default risk, ignoring other risk factors. Higher cost of acquiring information, higher cost of collateral seizure, and politically motivated behavior of state officials may make municipal bonds riskier than corporate bonds with the same rating and maturity. To incorporate all these risks, Trzcinaka proposes a random intercept model, a time varying intercept that estimates risk premium and reports that the coefficient of treasury bond yields was not significantly different from the corporate tax rate; this findings support Miller′s hypothesis. Furthermore, the time varying intercept is larger for longer maturities and for lower bond ratings. Fortune (1988) conducts a study aiming to reexamine Trzcinka′s (1982) study and shows that results reported by him are valid when personal income tax has lower variation. He recalculates Trzcinka′s model for the period 1976 to 1985, when the personal income tax rate showed large volatility, and finds that results vary substantially from those reported by Trzcinka. Subsequent research explores additional factors, other than the income tax rate of marginal investors, that influence the relative yields of taxable and tax-exempt bonds with similar credit ratings. These studies extend equation (2.1) in order to incorporate risk premium for additional risk factors associated with municipal bonds, and tax effect. A tax-exempt (municipal) bond pricing model can be written as:

$$R_M(n) = (1-t)R_T(n) + \lambda(n) \tag{2.2}$$

The term 'λ' represents the risk premium as a compensation for the greater risks associated with municipal bonds compared to taxable bonds of the same maturities and credit ratings.

Rosenbloom (1976) suggests that the call protection of municipal bonds can be a major risk factor, since it provides the issuer a right to buy back the existing bond for a pre-determined price when the present market interest rate is lower than the interest rate the bond offers. Thus, a call protected bond offers a risk premium over a non-call protected bond. Kidwell and Koch (1982) report that a yield differential exists between a general obligation municipal bond and a revenue municipal bond, and this yield differential is sensitive to the business cycle. They argue that revenue bonds are riskier than general obligation bonds because income from projects that guarantee servicing of these revenue bonds, varies along with the fluctuations in general economic conditions. In addition, banks prefer high quality general obligation bonds, since they meet regulatory requirements, are standard in nature, and fulfill banks′ commitment to local communities. In contrast, municipalities prefer to issue revenue bonds rather than general obligation bonds since municipalities have statutory restrictions and/or need voter approval in order to issue general obligation bonds. Thus, the municipal bond market is segmented between general obligation and revenue bonds, which causes a yield differential between these two kinds of bonds. Kidwell and Koch (1983) further show that the municipal bond market is segmented based on maturity. Investors do not consider two municipal bonds with identical default risks a perfect substitute for each other if one bond has a short-term maturity and the other has a long-term maturity. The supply side argument is that municipal governments often need constitutional amendments or public referendums to issue long-term bonds. Thus, they issue short-term bonds more often than long-term bonds in order to finance current operations. Their demand side argument is that commercial banks prefer short-term municipal bonds over long-term bonds because most banks′ liabilities are short-term in nature; as a consequence, short-term municipal bonds meet banks′ liquidity needs. Therefore, short-term municipal bonds offer lower yields than long-term municipal bond with similar default risks. Wang, Wu, and Zhang (2007) report that a liquidity risk premium constitutes a significant portion of municipal bond yields. Investors receive higher yields for bonds with returns that are more sensitive to market liquidity. Their study estimates that after controlling the effects of credit rating and maturity on yields, liquidity premium is higher for municipal bonds with a larger size and greater trading frequency.

Poterba and Rueben (1999) comprehensively estimate the impact of fiscal institutions on states′ borrowing costs using a model similar to equation (2.2). They argue that the budget rules and fiscal policies of states differ substantially in their fiscal institutions. Fiscal rules and policies, which are antideficit, reduce the borrowing costs for states as investors demand lower risk premiums for potential defaults. Poterba and Rueben (1999) estimate that balanced budget requirements, expenditure limit, and revenue limit have statistically significant impacts on borrowing costs. States with more stringent balanced budget rules, and/or constitutional limits on expenditure and revenue, have lower borrower costs in the municipal bond market.

Goldstein and Woglom (1991) estimated another municipal bond pricing model based on the capital theory of the determinants of expected return for assets in a diversified portfolio. In their model, they show that the spread between return from the municipal bond and the return from risk-free asset (U.S.treasury) depends on the probability of default for the municipal bond. The higher the default probability, the larger the spread will be.

$$R_M - R_T = (1 + R_T)(1 - \pi)/\pi \tag{2.3}$$

In equation (2.3), 'π' is the probability of default. Using Chubb insurance survey data, Goldstein and Wolgom estimate this model by considering the current debt and the size of the current budget deficit of a state, the trend growth in debt, and the constitutional limit of borrowing of a state as determinants of the probability of default. All these variables were found to have statistically significant explanatory power for probability of default.

Using Goldstein and Woglom′s (1991) model, Johnson and Kriz (2005) later estimated the impacts of fiscal institutions, debt limit, balanced budget rules, and tax and expenditure limits on default risks, credit ratings, and the borrowing costs of states. They report that expenditure limit, debt limit, and balanced budget rules have a statistically significant impacts on credit ratings, but do not have any impact on borrowing costs. Only revenue limit has a significant influence in the municipal bond market.

In the next chapter, a macroeconomic model of state borrowing costs is developed. This model is founded on principles of the real business cycle for states inside the U.S. monetary union. This model is more comprehensive than previous models because it develops both supply and demand side equations for a state economy, showing that the yield of municipal bonds is determined by interactions among different rational agents.

CHAPTER 3

A MACROECONOMIC MODEL FOR MUNICIPAL BOND PRICING

This study considers a monetary union with two states. Each state uses a common currency, and the monetary union has an independent central bank and a federal government. The central bank has the power to issue legal tender (common currency) for all states but does not distribute any seigniorage revenue to any member state. Moreover, the central bank does not finance the budget deficits of any state by purchasing its debts. This independent central bank has a constitutional responsibility to maintain price stability only, and not to inflate away member states$'$ debts or accumulate their debts to finance their budget deficits. Each member state of the union has its own government with the authority to manage and finance its own budget, and if there is a budget deficit, to collect taxes from factors$'$ income and to borrow from the financial market using the common currency. The federal government can provide budgetary supports to a state by intergovernmental transfer, which could be a substantial amount if any state defaults in its debt servicing. This chapter also assumes that the federal government has no constitutionally binding responsibility to bail out a state in case of default.

3.1 Supply of Goods and Services

Each state has an economy that produces goods and services utilizing three factors, based on Cobb-Douglas production function: capital (K), labor (L) and land (W). However, the production function is subject to random exogenous productivity shocks. Output or goods and services produced by i^{th} state and time period=t:

$$Y_{i,t} = e^{z_t} K_{i,t}^{\alpha} L_{i,t}^{\beta} W_{i,t}^{1-\alpha-\beta};\ \text{(i=1,2 \& t=1,2....n)} \tag{3.1}$$

The random productivity shocks, z_t follow the AR(1) process and $z_t = \rho z_{t-1} + \epsilon_t$, where ϵ_t is a white noise process. The production function has properties of constant return to scale and a diminishing marginal product of factors. According to this production function, the goods and services produced by each state depend only on its stock of capital, labor, and land.

For each state, the demand for capital, labor, and land comes from profit maximizing and perfectly competitive firms that are price takers in both output and input markets. Each firm hires factors until the marginal cost is equal to marginal revenue. In the absence of any market imperfection, such as involuntary unemployment, wage stickiness, and trade union power, factor markets clear when the marginal product of each factor is equal to the real factor price.

The firm′s objective function is to maximize $e^{z_t}PK_{i,t}^{\alpha}L_{i,t}^{\beta}W_{i,t}^{1-\alpha-\beta}-R_LL_t-R_kK_t-R_WW_t$ with respect to L_t, K_t and W_t. Thus, for i^{th} state and time period=t, the factor prices derived from first-order conditions are as follows:

$$\begin{aligned} \text{Real wage for labor: } MP_{i,t}^{L} = (\frac{R_L}{P})_{i,t} = e^{z_t}\beta K_{i,t}^{\alpha}L_{i,t}^{\beta-1}W_{i,t}^{1-\alpha-\beta} \\ \text{Real rental price for capital: } MP_{i,t}^{K} = (\frac{R_K}{P})_{i,t} = e^{z_t}\alpha K_{i,t}^{\alpha-1}L_{i,t}^{\beta}W_{i,t}^{1-\alpha-\beta} \\ \text{Real rental price for land: } MP_{i,t}^{W} = (\frac{R_W}{P})_{i,t} = e^{z_t}(1-\alpha-\beta)K_{i,t}^{\alpha}L_{i,t}^{\beta}W_{i,t}^{-\alpha-\beta} \\ \text{(i=1,2 \& t=1,2....n)} \end{aligned} \tag{3.2}$$

Under the full employment conditions for all factors, income share for each factor is as follows:

$$\begin{aligned} \text{Labor income share: } Y_{i,t}^{L} = \beta Y_{i,t} \\ \text{Capital income share: } Y_{i,t}^{K} = \alpha Y_{i,t} \\ \text{Land income share: } Y_{i,t}^{W} = (1-\alpha-\beta)Y_{i,t} \\ \text{(i=1,2 \& t=1,2....n)} \end{aligned} \tag{3.3}$$

Inside this monetary union, factors such as capital and labor move freely between the two states without any barrier, but land is immovable. Thus, the two states have equal after-tax real rent income for capital and after-tax real wage for labor, but may not have equal after-tax real rent income for the immovable factor, land.

Equal after-tax real factor income conditions for labor and capital between two states are as follows:

$$\begin{aligned} \text{For real wage of labor: } (1-\lambda_1^L)(\frac{R_L}{P})_{1,t} = (1-\lambda_2^L)(\frac{R_L}{P})_{2,t} \\ \text{For real rent of capital: } (1-\lambda_1^K)(\frac{R_K}{P})_{1,t} = (1-\lambda_2^K)(\frac{R_K}{P})_{2,t} \\ \text{For real rent of land: } (1-\lambda_1^W)(\frac{R_W}{P})_{1,t} \neq (1-\lambda_2^W)(\frac{R_W}{P})_{2,t} \\ \text{(i=1,2 \& t=1,2....n)} \end{aligned} \tag{3.4}$$

Here, λ_i^L, λ_i^K and λ_i^W are i_{th} state tax rates on incomes from labor, capital, and land, respectively. These tax rates on factor incomes are determined by state governments.

The first major implication of equal after-tax real factor income conditions is that no state government in this monetary union can arbitrarily decide the tax rate on real rent of capital or real wage of labor. Before deciding the tax rates for labor and capital incomes, a state government must conform to the equal after-tax real income conditions for both labor and capital. If one state increases the tax rate on the real rent of capital or the real wage of labor, and violates the equal after-tax real factor income conditions, then capital or labor moves from the state that has the lower after-tax real rent or wage to the state that has the higher. This effect continues until the marginal productivity of capital or labor of the original state increase sufficiently to satisfy these conditions again. Losing factors to another state consequently reduces the total output and tax revenue for the original state. But provided, however, that the tax is not higher than real rent income from land, each government can apply any tax rate on the real rent of land since this factor is immovable. The maximum tax rate for land income in any state can be between 0 and 100%.

A second implication is that both states must have equal after-tax risk-free interest rates. The risk-free rate for each state is determined by its real rent of capital. The after-tax real rent of capital is the same for both states.

$$\text{Risk free rate of interest: } R_{f,i,t} = (\frac{R_K}{P})_{i,t} = e^{z_t}\alpha K_{i,t}^{\alpha-1} L_{i,t}^{\beta} W_{i,t}^{1-\alpha-\beta} \quad \text{(i=1,2 \& t=1,2,....n)} \tag{3.5}$$

The equal after-tax risk-free interest rate condition for two states:

$$(1-\lambda_1^k)R_{f,1,t} = (1-\lambda_2^k)R_{f,2,t} = r_{f,t} \tag{3.6}$$

3.2 Demand for Goods and Services

For every state, the demand for goods and services is the sum of current period consumption, investment, government spending, and net export,

$$Y_{i,t} = C_{i,t} + I_{i,t} + G_{i,t} + NX_{i,t}; \text{(i=1,2 \& t=1,2,....n)} \tag{3.7}$$

Interstate trade between the two states inside the union comprises the net export. We assume that net trade is exogenously determined for each state in this model. The demand for private investment goods is determined by the capital accumulation process in every state,

$$I_{i,t} = K_{i,t} - (1-\delta)\ K_{i,t-1}; \text{(i=1,2 \& t=1,2,....n)} \tag{3.8}$$

where δ=capital depreciation rate. However, the demand for goods and services due to private consumption and government spending in each state arises through intertemporal two-period utility maximizations by private individuals and through government budget constraint, respectively.

3.2.1 Government Spending

The government in every i_{th} state allocates budgetary spending ($G_{i,t}$) for its operating and capital expenditures at every time period=t, and this $G_{i,t}$ is exogenously determined by i_{th} state at time period t. Thus, it collects taxes (T_{it}) on the labor, capital, and land incomes of individual residences (the tax rates on land, labor, and capital income are exogenously determined by state governments) at time period t, and also borrows (b_{it}) from the financial market at large.

$$\begin{aligned} T_{i,t} &= \lambda_i^L Y_{i,t}^L + \lambda_i^K Y_{i,t}^K + \lambda_i^W Y_{i,t}^W \\ &= \lambda_i^L \beta Y_{i,t} + \lambda_i^K \alpha Y_{i,t} + \lambda_i^W (1-\beta-\alpha) Y_{i,t}^W \end{aligned} \tag{3.9}$$

We assume that every state government in the union has the self-interest to maximize budget spending, but states cannot run a ponzi scheme and do not receive the seigniorage revenue from the central bank. We also assume that a government can issue a one-year maturity debt (b_i) at any period $t = t$ with an interest rate r_m. This debt matures during the next period. At t=1, the government budget constraint for i_{th} state in the monetary union is:

$$G_{i,1} = T_{i,1} + b_{i,1} \tag{3.10}$$

At t=2, the budget constraint becomes:

$$G_{i,2} = T_{i,2} - (1 + r_{m,i}) b_{i,1} \tag{3.11}$$

The implications of this budget constraint are that a government in the monetary union can finance its budget spending by tax revenue and by borrowing from the financial market. A government can default at t=2 and avoid paying accrued interest and principle for the debt accumulated at period t=1, i.e., $b_{i,1}$. In case of defaults, however, a government cannot continue to have access to the capital market and cannot borrow to finance primary budget deficits in the future. Thus, the budget constraint at t=2 implies,

$$G_{i,2} = T_{i,2} \text{ (if defaults)}$$

$$G_{i,2} = T_{i,2} - (1 + r_{m,i})\ b_{i,1} \text{ (if does not default)}$$

3.2.2 Consumption

We assume that a representative individual of i_{th} state makes consumption and savings decisions between t=1 and 2 periods and maximizes his or her utility. He or she derives utility from consumption, and his or her utility increases with consumption. At period t=1, an individual of i_{th} state earns after-tax labor income, $y_{i,1}$ and consumes, $c_{i,1}$. Savings, $y_{i,1} - c_{i,1}$, is invested in a diversified portfolio of assets and r_k is the after-tax return from k^{th} asset. So, at period t=1, the individual budget constraint is,

$$c_{i,1} + s_{i,1} = \ y_{i,1} \tag{3.12}$$

At period t=2, this individual earns after-tax labor income, y_2 and enjoys the previous period$'$s after-tax investment income, $[y_{i,1} - c_{i,1}][\sum w_k(1 + r_k)]$, where k=1,2,.....K assets. At period t=2, the individual has the following budget constraint:

$$c_{i,2} = y_{i,2} + [(y_{i,1} - c_{i,1}][\sum[w_k(1 + r_k)] \tag{3.13}$$

The maximization problem for this individual$'$s time additive utility can be written as: max $U(c_{i,1}) + \beta E(c_{i,2})$ subject to $c_{i,2} = y_{i,2} + [(y_{i,1} - c_{i,1}][\sum_k[w_k(1 + r_k)]$, and $\sum w_k = 1$, k=1,2,..K assets. With respect to $c_{i,1}$ and w_k, from the first-order conditions, we obtain the following equations:

$$\begin{aligned} U^{'}(c_{i,1}) &= \beta E[U^{'}(c_{i,2})(1 + r_k)] \\ E[U^{'}(c_{i,2})(1 + r_k)] &= E[U^{'}(c_{i,2})(1 + r_j)] \end{aligned} \tag{3.14}$$

Under the assumption of nonstochastic consumption, these equations become,

$$\begin{aligned} U^{'}(c_{i,1}) &= \beta U^{'}(c_{i,2})E(1 + r_k) \\ E(1 + r_k) &= E(1 + r_j) \end{aligned} \tag{3.15}$$

The first of the equations in equation (3.15) estimates that an individual of i_{th} state allocates his or her resources between periods 1 and 2 so that he or she maximizes utility from first-period consumption with a discounted expected utility from second-period consumption weighted by the expected return from k_{th} asset. The second of the equations in equation (3.15) estimates that the individual allocates his or her savings in different assets in the portfolio until the expected return from each asset is equal.

3.3 Municipal Bond Yield Determination

We assume that the representative individual residence of a state invests his or her savings in a diversified portfolio of assets and he or she is a risk-averse investor. His or her portfolio consists of risk-free assets as well as risky municipal bonds. At t=1, this investor knows the government spending, $G_{i,1}$, and tax income, $T_{i,1}$, when he or she buys state government debts that will be matured at period, t=2. Although he or she is aware of the fact that at t=2 period, a government must maintain the budget constraint (3.11) or default, government spending, $G_{i,2}$, and tax income, $T_{i,2}$, at period t=2 are unknown to him or her.

If 'π_i' is the probability of default (PD) of the i^{th} state government over a 1-year horizon, and 'x_i^e' is the expected loss given default (LGD) by investors if i^{th} state defaults during t=2 period. If $r_{m,i}$ is the yield on the government bond of i^{th} state at t=1 period, then the expected return for a risk-averse investor from the government bond of i^{th} state is,

$$\begin{aligned} E(1+r_{m,i}) = (1+r_{m,i})(1-\pi_i) + (1+r_{m,i}-x_i^e)(\pi_i) &= 1+r_f \\ \text{or, } r_{m,i} &= r_f + \pi_i x_i^e \qquad (3.16) \\ \text{or, } r_{m,i} - r_f &= \pi_i x_i^e \end{aligned}$$

Equation (3.16) states that the yield on a state bond is a function of the risk-free interest rate and expected loss ($EL = \pi x^e$) for investors from that bond, whereas the probability of default of a borrower state (PD) and the expected loss given default (LGD) determine the expected loss (EL). Another interpretation is that the spread between yield on a state bond and the risk-free rate is the risk premium, which is equal to expected loss (EL) from that bond.

3.3.1 Risk-Free Rate and Expected Loss

The risk-free rate is the foundation for pricing a municipal bond, and it sets the floor for the borrowing cost of a U.S. state. Any up or down movement of the risk-free interest rate should immediately change the yields on municipal bonds in the same direction. In this model, the risk-free rate is equal to the marginal product or real rent of capital, and it is subject to random exogenous productivity shocks. Each state has the similar risk-free rate because of arbitrage activity, and any exogenous shock that changes the productivity of capital in the union also changes the real interest rate.

Expected loss (EL) is the loss that may have to be incurred by investors as a result of lending to a risky borrower state. EL is calculated by multiplying probability of default (PD) and loss given default (LGD) as a percentage of loan exposure amount, and is equal to the risk premium that investors receive as a compensation for lending to a risky state. The higher is the expected loss by investors, the larger is the risk premium investors demand over risk-free interest rate.

When a state becomes unable to service its debt, it can default completely on its debt, or it can negotiate with creditors for a partial default. In case of partial default, the defaulting state and its creditors negotiate to settle the amount of loss given default (haircut) that creditors must accept. Therefore, expected loss given default (haircut) is an important determinant of yields on municipal bonds. The amount of haircut investors might incur is a function of the existing debt and fiscal health of a state, and the ability and willingness of the federal government to make intergovernmental transfer.

In this macroeconomic model, the most important factor that impacts the default probability of a borrowing government in the monetary union is the existing stock of debt and current borrowing. If any state government in this monetary union runs a budget deficit, it must borrow from the financial market. A persistent budget deficit forces this state to accumulate debt, and the state must achieve a larger primary budget surplus in the future as the size of the debt level grows. Consequently, the default probability of the state increases with the increase of debt stock, and so does the borrowing cost for this state. In addition, an increasing borrowing cost also worsens the financial situation of a state and its default probability further increases. Therefore, the stock of debt and default probability of a state have a nonlinear relationship (Goldstein & Woglom, 1991).

This model also anticipates that the default probability of a borrower government is influenced by factors that are exogenously determined. The higher the probability or frequency of these exogenous shocks, the larger the default probability of a government, and the higher would be its borrowing cost. Therefore, exogenous shocks (on both supply and demand sides of a state economy) influence the yield on the municipal bond.

Sudden shocks to factor productivities (labor, land, and capital), a substantial migration of labor from one state to another (due to some adverse public policies in the original state), natural disasters, epidemics, and oil price hikes may create shocks to the supply side of the economy of a state. These exogenous shocks cause the output of a state to decline, which ultimately leads to lower tax revenue as well as to, on some occasions, higher public spending. In response to these conditions, a state government may default to service the debt.

An exogenous demand shock, such as a business recession or financial crisis, reduces investment expenditure, consumption, and interstate trade. In addition, the size of the unemployed population often increases, and the size of the tax paying employed labor force decreases. Thus, a downward pressure on all types of factor income takes place, which ultimately dampens the tax revenue for a state government. A rising default probability for a state government is the ultimate outcome.

3.4 Demand for Funds by a State Government

The demand for funds by a state government depends on its decision to finance the budget by taxation or by borrowing, that is, the size of the primary budget surplus/deficit. Two important factors that influence deficit financing decisions are fiscal institutions and political institutions.

3.4.1 Fiscal Institutions

States in the U.S. monetary union have different fiscal institutions. With the exception of Vermont, each state has a balanced budget requirement, but the stringency of these requirements varies widely (Mitchell & Tuszynsky, 2011). These balanced budget requirements can be categorized into four groups. In 44 states, a budget proposed by the governor must be balanced. This is weakest of all balanced budget rules. In 37 of these states, the enacted budget must be balanced, while the actual revenues and expenditures can be subtracted from the balance if expectation differs from realization. In 6 states, deficits in one period must be corrected in the next, and in 24 of the 37 states no deficit can be carried forward from one fiscal period to another. This is the strictest of all balanced budget rules (Poterba & Rueben, 1999).

The second fiscal institutions is debt limit, which is any type of debt restrictions that account for a state′s constitutional and/or legislative limit when issuing long-term general obligation bonds and/or the limits on the amount of debt outstanding. Ten states have no debt restrictions. Of the other 40 states, 38 have constitutional and the other two have legislative restrictions (Poterba & Rueben, 1999).

The final two fiscal institutions are revenue limit and expenditure limit. These rules determine the constitutional and/or legislative limit(s) within a state for tax or expenditure. The objective of these rules is to control the growth of governments. They limit the growth rate of revenue or expenditure to the growth rate of state residents′ personal income, the state population,and the inflation rate, or some combination of all three. Twenty-eight states implemented these laws (Mitchell & Tuszynsky, 2011).

3.4.2 Political Institutions

Political institutions often influence states′ fiscal profligacies, tax increases, or public borrowings and, therefore, have an impact on the demand for funds by a state from the financial market, and thus, on its borrowing cost. The political institutions that have the greatest impact and the greatest effect in this model are the party affiliations of the governor and the majority members in the senate or house of a state; the size of the legislative branches of a state, such as the total numbers of senate and house seats; a split legislature, that is whether two houses are ruled by the two different parties; and labor union density in a state.

The party affiliations of the governor and the status of senate or house members are proxies for conservative and liberal political forces that have different ideological views regarding the intergenerational transfer of wealth. Conservative forces often limit the size of the fiscal budget, contravene against higher taxes, or discourage public borrowings, but they often achieve these ends by cutting the public goods to society. The third political institution is the size of a state′s legislature, i.e., the total numbers of senate and house members. A state government′s size often determines the impact of the larger legislative body on government spending. Electorates have self-interest to internalize the benefit of public projects, but due to cost sharing they also underestimate project costs. Thus, the size of the legislative body is associated with the amount of government spending. A larger state legislature usually increases the government spending for the state. The fourth political institution, the presence of a split legislature, deters a single party from dominating public budgeting and, thus, checks the fiscal profligacy.

The final political institution is the organized labor in a state. This interest group impacts the size and composition of a state budget. This study assumes that a state with a larger union membership or strong collective bargaining is less capable of undertaking painful fiscal austerities in the case of fiscal crisis and thus, is more prone to debt repayment default.

3.5 Conclusion of the Macroeconomics Model

The municipal bonds issued by U.S. states vary in basic characteristic factors. These factors include (a) the issue size of a bond, (b) the existence of call provision for a bond, (c) the maturity of a bond, (d) the eligibility of interest income from the bond for a state tax, (e) the credit rating of a bond, (f) the bond is insured by a third party, and (g) the method of a bond′s sale, as competition or negotiation. Other than the default probability (PD) and loss given default (LGD), these bond factors also determine the spread between the yields of a state bond and the risk-free debt, as shown in equation (3.15). The issue size of a bond is expected to have a negative effect on yield because a large volume of a particular bond offers higher liquidity for the investors. Therefore, investors may receive lower yields from a bond with a larger issue. A callable municipal bond offers a higher positive risk premium than a non-call protected bond, since call protection provides the issuer an opportunity to buy back the existing bond for a predetermined price when the market interest rate is lower (Rosenbloom, 1976). Since the price of a bond is determined by the discounted value of future cash flow, the price of a longer maturity bond is more vulnerable to market interest rate changes than the price of a shorter maturity bond. Since market interest rate is often volatile and this volatility creates interest rate risk for investors′ portfolios, a longer maturity bond often compensates investors with a higher return. Poterba (1999) and Liu and Thakor (1984) estimate risk premiums for municipal bonds if interest income from the bonds is eligible for a state tax, or if the bonds have lower credit ratings. In addition, Johnson and Kriz (2005) find that insurance offered by a third party negatively affects yields on municipal bonds because insured bonds have a lower risk of nonpayment. Finally, yields on municipal bonds differ if a bond is offered by negotiation or by competitive bidding.

CHAPTER 4

EMPIRICAL ANALYSIS OF THE MACROECONOMIC MODEL-I

In this chapter, an empirical analysis is conducted to estimate the impact of different variables (shocks) on the borrowing cost of a state as prescribed by the macroeconomic model. This model predicts that yield on municipal bonds for a state is a function of risk-free interest rate and expected loss (EL) for investors from lending to the state, whereas expected loss ($EL = \pi x^e$) is the product of probability of default (PD) of a state and expected loss given default (LGD) of that state for investors. Although risk-free interest rate can be modeled using yields on U.S. treasury securities as an instrument variable, expected loss for an investor is not observable. It is a latent variable. Nevertheless, the expected loss (latent variable) can be determined by a linear combination of several instrumental variables, such as the credit rating of a state, fiscal and political institutions, and important macroeconomic variables. Let us assume that $'X'$ is the vectors of all explanatory variables that are linearly related with the expected loss (EL) variable, then the linear function can be written as,

$$EL = \beta X + \epsilon$$

A linear regression model based on equation (3.10) can be written as,

$$r_{m,i} = (1-t)r_f + \beta X_i + \epsilon_i$$

where 'i' represents the i_{th} state. 't' is the federal tax rate on risk-free treasury bond yield. In equilibrium,'t' is determined by the income tax rate of the marginal buyer of a tax-exempt municipal bond. This linear model relates different predictor variables (shocks) to a specific response variable, namely the yields of general obligation bonds, and can be estimated using fixed effect or least square dummy (LSDV) panel data regression technique.

A panel regression method is widely used to estimate a linear model. This technique depicts the relationship between a set of predictor variables (Xs) and a response variable (Y) when a dataset follows a given sample of individuals over time, and thus provides multiple observations on each individual in the sample (Hsiao, 2003). For a linear relationship, the equation for a panel data can be,

$$Y_{it} = \sum_{i=1}^{N} \alpha_i E_i + \sum_{t=1}^{T} \gamma_t T_t + \beta_1 X_{it,1} + \beta_2 X_{it,2} + ... + \beta_p X_{it,p} + \epsilon_{it} \tag{4.1}$$

where αs and γs are coefficients for 'N' cross section and 'T' time dummies that mimic the individual and time effects in panel regression. βs are coefficients of predictors$'$ variables and ϵ is the disturbance term. If X is the $(n*p)$ matrix of predictor variables with n observations, then the regression model can be written as a vector form: $Y = X\beta + \epsilon$, where Y and ϵ are the $(n*1)$ vectors of the response variable and the disturbances, respectively, and β is the $(p*1)$ vector of coefficients.

The LSDV method uses the ordinary least square (OLS) technique that minimizes the $\sum(\epsilon^2)$ with respect to β and finds an estimator of β: $\hat{\beta}$=$(XX')^{-1}X'Y$. The estimated $\hat{\beta}$ is considered the best linear unbiased estimator (BLUE); its variance, $var(\hat{\beta})$=$\sigma^2(XX')^{-1}$ is the minimum, and it is unbiased among all of the linear estimators of β, provided that the X matrix has the full rank. In addition, this estimator of β is also the Maximum Likelihood Estimator (MLE) and is the most efficient among all estimators of β as long as disturbances are normally distributed with zero mean and constant variance, $\epsilon \sim N(0, \sigma^2 I_n)$.

4.1 Bond Characteristics, Institutions, and State Economy

The first empirical work estimates a linear model that relates predictor variables-the municipal bond characteristic factor to a specific response variable- the yields of general obligation bonds state fiscal institutions, political institutions, and state economic variables to a specific response variable- the yields of general obligation bonds after controlling for the municipal bond characteristic factors. Table (4.1) summarizes these variables. The regression model is founded on equation (4.1) and is depicted as follows:

$$\begin{aligned} municipalyield_{it}(n) = \beta_o + \beta_1 treasuryyield_{it}(n) + \sum_j \beta_{2,j} bondfactors_{it} \\ + \sum_j \beta_{3,j} fiscalinstitutions_{it} + \sum_j \beta_{4,j} politicalinstitutions_{it} + \sum_j \beta_{5,j} economicshocks_{it} \\ + \epsilon_{it} \end{aligned} \tag{4.2}$$

The response variable in this LSDV regression analysis for equation (4.2) is the primary market yields on municipal bonds issued by state governments in the U.S. monetary union. The dataset of this response variable covers a total of 17,400 general obligation bonds issued in the primary market by 37 states between the years 2001 and 2011. This bond dataset is collected from the Mergents Bond Viewer data base for U.S. taxable and municipal bonds. This sample is chosen based upon the availability of the most recent data, the size of the data, and the time and budget constraints of the researcher. As an example, this sample includes 37[1] states rather than all 50 because the other 13[2] states did not offer general obligation bonds during the sample period.

The first predictor variable is the pre-tax treasury yields. The pre-tax municipal yields are matched with pre-tax treasury yields by the date of sales (month/year) and number of years to maturity of municipal bonds for each month of the year, lasting from 2001 to 2011. Although the number of years to maturity for municipal bonds ranges from 1 to 35 years, treasury securities are offered only for the following maturities: 1-month, 3-month, 6-month, 1-year, 2- year, 3-year, 5-year, 7-year, 10-year, 20-year, and 30-year. Therefore, in order to match pre-tax municipal bond yields with pre-tax treasury yields by the number of years to maturity, the yield curves for treasury securities that cover from 1 year to 35 years are constructed in the form of a spline function for each month of the year from 2001 to 2011. This spline function estimates the yield to maturity as a linear function of maturities (Johnson & Kriz, 2005). The data for the treasury yields are collected from the Board of Governors of the Federal Reserve.

Fiscal institutions are the second set of predictor variables. These are the *ACIR index*, *debt limit*, *revenue limit*, and *expenditure limit*. The ACIR variable is an index of constitutional and legislative limits of fiscal deficit for each state. As previously noted, with the exception of Vermont, each state has a balanced budget requirement, but the stringency of these requirements varies widely (Mitchell & Tuszynsky, 2011). A balanced budget rules-based index has been developed by the Advisory Council on Intergovernmental Relations (ACIR, 1987) based on the existence and implementation of balanced budget rules. This ACIR index for budget stringency ranges from 0 (for states with very lax antifiscal deficit rules) to 10 (for states with very stringent fiscal deficit rules).

Political institutions are the third set of predictor variables, and include the party affiliations of the governor and the party affiliations of the majority senate or house members of a state, the size of a state′s legislative branches (the total numbers of senate and house

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[1]Alabama, Alaska, Arkansas, California, Connecticut, Delaware, Georgia, Hawaii, Illinois, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Montana, Nevada, New Hampshire, New Jersey, New Mexico, New York, North Carolina, Ohio, Oklahoma, Oregon, Pennsylvania, South Carolina, Tennessee, Texas, Utah, Vermont, Virginia, Washington, West virginia, and Wisconsin.

[2]Not included in data set: Arizona, Colorado, Florida, Indiana, Iowa, Kansas, Kentucky, Nebraska, North Dakota, Rhode Island, South Dakota, Washington D.C, and Wyoming.

seats), the existence of a split legislative body ruled by two different parties, and the labor union density in a state.

The *governor affiliation* variable takes the value 1 if the governor of a state is affiliated with the Republican Party and 0 otherwise. The *senate affiliation* variable takes the value 1 if the majority of senate members are affiliated with the Republican Party and 0 otherwise. Finally, the *house affiliation* variable takes the value 1 if the majority of house members are affiliated with the Republican Party and 0 otherwise. Therefore, all three are dummy variables.

The *size of legislative* variable measures the total number of members in both the house and senate of a state. A *split legislature*, a dummy variable, takes the value 1 if the senate and house of a state are ruled by two different parties. Data for these two variables are collected from the U.S. census bureau. Organized labor in a state is accounted for according to the *union density by state*. It equals the percentage of nonagricultural wage and salary workers (including public sector employees) who are union members in a state. The data for union density by state are collected from the works of Hirsch et al. (2014). A description of the data base can be found in Hirsch et al. (2001).

A fourth set is statewise economic variables vulnerable to exogenous shocks. They carry those shocks to a state′s repayment capacity of existing debt and should be priced in the municipal bond market. Five state economic variables are identified.

One variable is *unemployment* for each state. This variable represents a state′s revenue/tax production capacity. A larger unemployed population in a state generates less tax revenue and also increases the welfare expenditure for a state. The unemployment variable is the number of people unemployed in a state as a percentage of the total labor force in a state. Unemployment data are collected from the Bureau of Labor Studies. The second variable is *Home price index* (HPI) that concerns the wealth of state residences and the state government. Higher home prices also represent higher tax revenue for school districts and local governments, which ultimately relieve the state from having to support local governments′ fiscal budgets. HPI data are collected from the St. Louis Federal Reserve Data Base (FRED).

The following three variables represent present and future fiscal obligations for a state: *budget deficit*, *existing debt*, and *public pension funding*. Since a state does not have any seigniorage revenue, all budget deficit must be financed by borrowing from the municipal bond market. Thus, the budget deficit of a state represents an increase to its existing debt level and future obligations for repaying and servicing these debts. The existing debt of a state demands servicing of the debt by interest payment and repayment of principals for matured debts. Thus, a larger debt obligation of a state creates fiscal pressure for a state and diverts money from development, education, and welfare. Budget deficit and existing debt variables are standardized by dividing them with the respective state′s personal income. The data are collected from the United States Census Bureau.

The public pension obligation of a state is represented by creating a variable *pension fund of a state*. The pension fund is the ratio of the actuarial asset and liability of a state for a year. During the past several years, state governments have been increasingly under fiscal pressure due to rising public pension costs and liability. The recent recession has made the situation worse for most states. The actuarial firm Milliman estimates a 1.2 trillion dollar gap for the largest 100 U.S. public pension plans (Sielman & Rebecca, 2012). Since today′s underfunded state public pension system will be a substantial future fiscal obligation for states, this study examines whether the municipal bond market demands a risk premium for this looming fiscal risk. The pension funding ratio dataset is collected from the pension data base of the Center of Retirement Research, administered by Boston College.

The control variables are derived from the bond-specific factors that affect the yield on a municipal bond in the primary market. Factors include the *issue size* of a bond, the existence of *call provision* for a bond, the *maturity* of a bond, the *state tax* on interest income from the bond, the *credit rating* of a bond, a bond′s *insurance* by a third party, and the method of sale for a bond, i.e., whether it is sold *competitively or by negotiation*. The issue size of a bond is expected to have a negative effect on yield because a large volume of a particular bond offers higher liquidity for the investors. Therefore, investors may receive lower yields from a bond with a larger issue. A callable municipal bond offers a higher positive risk premium than a noncall protected bond, since call protection provides the issuer an opportunity to buy back the existing bond for a predetermined price when the market interest rate is lower (Rosenbloom, 1976). Since the price of a bond is determined by the discounted value of future cash flow, the price of a longer maturity bond is more sensitive to market interest rate change than the price of a shorter maturity bond. Since market interest rate is often volatile and this volatility creates interest rate risk for investors′ portfolios, a longer maturity bond often compensates investors with a higher return. Poterba (1999) and Liu and Thakor (1984) estimate risk premiums for municipal bonds if interest income from the bonds is eligible for a state tax, or if the bonds have lower credit ratings. In addition, Johnson and Kriz (2005) find that insurance offered by a third party negatively affects yields on municipal bonds because insured bonds have a lower risk of nonpayment.

Finally, yields on municipal bonds differ if a bond is offered by negotiation, or by competitive bidding.

The issue size variable is the logarithmic value of the issue amount of a municipal bond while the bond is sold. Dummy variables, such as option, insurance, state tax, and negotiation, are employed to control the impacts of call provision, insurance offered by a third party, state tax on interest income, and the use of negotiation for sale. In order to capture the maturity effect on yields, two maturity-based dummy variables are employed: short (for bonds with maturity between 1-5 years) and medium (for bonds with maturity between 6-12 years). Credit ratings for a municipal bond are collected from three rating agencies: Moody, S&P, and The Fitch. These nonnumeric bond ratings are then converted into ordinal variables by assigning a numeric value to each rating group: 0 for the highest credit quality (AAA), 1 for very high credit quality (AA), 2 for high credit quality (A), 3 for good credit quality (BBB), and 4 for all other speculative grades and nonrated bonds. The rating variable is created by taking the numeric value of the highest of the three credit ratings. The data for all these bond factors are collected from the Mergents Bond Viewer data base for U.S. taxable and municipal bonds.

Table (4.2) summarize the estimated fixed effect (LSDV) regression results that regress yields on municipal bonds against fiscal institutions, political institutions, and state economy, after controlling a bond′s characteristics factors. These fixed effect estimations also calculate robust standard error for inference purposes in order to control the presence of heteroskedasticity in error terms. In table (4.2) for the full sample, the estimated results provide a good fit between the data and the actual municipal bond yields. The R-square value (0.87) shows that the model predicts 87% variation in yields on municipal bonds. The coefficients for all but one explanatory variables (state tax) are statistically significant. The coefficient of the treasury variable is 0.57, which means this model predicts a 43% tax rate for marginal investors of municipal bonds. The coefficients for all bond factor variables′ are statistically significant and stable in the full sample, and with some reasonable exceptions, also in other three shorter, medium, and longer maturity samples. Issue size is priced in the municipal bond market. This model estimates a yield increase of 0.03% if issue size increases by 1%. This model also estimates the risk premiums for call provision, insurance offered by a third party, and the negotiation offering method, as expected. It predicts 0.12% or 0.04% higher yields if a municipal bond has a call option or has one additional group of lower credit ratings. Additionally, the model predicts 0.12% and 0.14% lower yields for both cases if a bond is insured by a third party and offered by negotiation, rather than by competitive bid. The maturity effect is also being priced in the municipal bond market as expected. Shorter and medium maturity bonds offer 1.17% and 0.10% lower yields than longer maturity municipal bonds. In addition, a shorter maturity bond and a medium maturity bond offer 0.09% and 0.07% higher yields, respectively, for 1 additional year of maturity. Finally, this model does not offer any risk premium if interest income from municipal bond is subjected to the state tax by the issuer state.

It is clear that signs and strengths of coefficients, as well as statistical significances of all bond factor variables, remain unchanged across the maturity groups (stable), except the option, credit rating, and state tax variables. The option dummy variable has a statistically significant coefficient for the full sample, long; but a statistically insignificant coefficient for the short and the medium maturity sample. For a short or a medium maturity bond, there may not be much interest rate risk for investors if a call option exists. The credit rating variable is statistically significant and has expected positive signs for the full sample, the medium maturity sample; but the coefficients are statistically insignificant for the short and long maturity sample. In addition, the coefficient of state tax is statistically insignificant for all samples except long maturity.

The coefficients for all fiscal institution variables except revenue limit are statistically significant for the full sample. For every additional point in the (1-10) ACIR scale, the municipal bond market reduces the interest rate for a state by 0.006%. The municipal bond market offers 0.04% and 0.02% lower interest rates for a state that has a constitutional limit on expenditure and debt. The coefficients of all the fiscal institution variables, however, are not stable and significant across the three maturity samples. The coefficient of the ACIR (the balanced budget rules index) is significant in the full sample and the short, medium and long maturity sample. On the other hand, the coefficient of the expenditure limit is statistically significant and stable for the full sample and also for the medium and the short maturity sample. The coefficient of debt limit is statistically significant only for full sample. In addition, the revenue limit fiscal institution variable is statistically significant in full sample and in short and longer maturity samples.

All but one of the political variables are statistically significant for the full sample, and signs and magnitudes do not follow the expectations of this study. The municipal bond market reduces the interest rate for a state by 0.13% and 0.03%, respectively, if a majority of senate and house members are affiliated with the Republican Party. Surprisingly, the municipal bond market charges 0.04% higher interest rate for a state that has a split legislature, i.e., senate and house are ruled by two different parties. The municipal bond market also demands a 0.15% positive risk premium for the size of legislation variables. For one additional legislator per capita, a state pays a 0.15% higher interest rate, which seems a little too much. The municipal bond market prices union density in a state adversely by charging 0.06% higher interest rate for 1% additional labor force covered by a union or collective bargaining. Finally, the coefficient for governor affiliation is statistically insignificant for full sample.

Again, coefficients of all the political institution variables are not stable and significant across the three maturity samples. The coefficient of the governor affiliation variable is statistically insignificant for the medium maturity samples but significant for the short and long maturity sample. The Coefficient of house affiliation variable is insignificant in all but the long maturity sample but the coefficient of the senate affiliation variable is stable and significant across all three maturity samples. For the size of legislation and split legislature variables, the coefficient of size legislation is insignificant for all three maturity samples, but the coefficient of split legislation is significant for all but the short maturity sample. The coefficient for the union density variable is stable and significant in all three maturity samples.

Among the state economic variables, unemployment is statistically insignificant and has the opposite effect than expected. Both debt and deficit variables generate statistically significant coefficients. For 1% additional debt/income or deficit/income, a state is punished with 0.02% and 0.002% additional borrowing costs, respectively. It seems that the municipal bond market cares more about the past accumulated debt than the current period deficit. The Home price index (HPI) is also statistically significant. A 1% additional HPI rewards a state with 0.001% lower borrowing costs. Finally, the pension funding variable produces a statistically significant coefficient. States are punished by 0.002% additional borrowing costs if the pension funding ratio of a state deteriorates by 1%.

Across the maturity based samples, the significance of state economy variables show mixed results. The coefficient of debt variable is insignificant for all samples, whereas the coefficient of deficit variable is significant only for the long maturity sample. The coefficient for the home price index is significant for all but the short maturity sample, but the coefficient for the pension fund is insignificant for all three maturity-based samples.

4.2 Model Diagnostic Test

Although this study successfully developed a regression model based on bond characteristics, fiscal institutions, political institutions, and state economic variables, and fit the data with a 87% R-square value, it is essential to diagnose the BLUE properties of the estimator of the coefficients. One starting point would be to estimate the multicollinearity among the independent variables, i.e., estimating the Variance Inflation Factor (VIF). Any VIF value greater than 10 would be an indicator of higher correlation among the independent variables. From the regression model of equation (4.2), the mean VIF score for all regressors is calculated to be 4.17. Overall, it can be safely inferred that linear dependence among regressors in this model is negligible, and the estimators of the coefficients for this regression model retained the BLUE property.

Three F-tests examine whether all bond character factors, all fiscal institutions, and all budget variables are blockwise jointly zero. These F-tests show that the coefficients for all groups are block wise jointly nonzero (p-value less than 1%). Thus, the presence of these three groups of variables in the regression model is justified. Thus, no risk factors should be dropped from the regression model even if any factor is statistically insignificant based on an individual t-test.

Next, the assumption of normality of the error term could be another property to examine for the regression model. The assumption that errors of the regression model follow normal distribution, $\epsilon \sim N(0, \sigma^2 I_n)$, is essential for the estimators of the coefficients to be the most efficient estimators among all classes of estimators. A standard Jarque-Bera test for normality of error term is used for this study to examine the validity of the above mentioned assumption. For this regression model, the JB statistics is calculated as 594880. The chi-square critical value at the 5% level of significance and 2 degrees of freedom is 5.99. Thus, the null hypothesis of normality is rejected. Since the regression model generated nonnormal error terms, the estimators of the coefficients for this regression model may not be the most efficient. Thus, t-statistics calculated for statistical inference should be accepted with caution.

4.3 Model Validation

Model validation refers to finding the correct model, stability, and robustness of estimators of the regression coefficients, as well as the plausibility and usability of the regression function for prediction and ability to generate inferences drawn from the regression function (Oredein et al., 2011). Snee (1977) emphasized the model validation by arguing that data collected without the aid of an experimental design may have several defects. Both the dependent and independent variables may contain errors, both types of variables may not have sufficient variations, and important variables may be missing. Thus, some type of validation should be made before using any model for prediction. There are several methods for model validation, e.g., cross validation, bootstrapping, etc. Each validation model has advantages and disadvantages. Oredein et al. (2011) estimated several model validation techniques for a regression model and found that bootstrapping provides the lowest prediction errors.

Bootstrapping avoids any assumption of the distribution for a population or for an estimated population parameter. The bootstrap method selects B number of independent bootstrap samples $(X^{*1}, X^{*2}, ...X^{*b})$ of size n drawn from the original sample (F) with replacement: $X^* = (x_1^*, x_2^*, x_3^*, ...x_n^*)$; $F = (x_1, x_2, x_3, ...x_n)$, where star sign (*) indicates X^* is a re-sample version of X. Then it calculates the bootstrap replication $\hat{\theta}^* = (\hat{\theta}^{*1}, \hat{\theta}^{*2}, \hat{\theta}^{*3}, ...\hat{\theta}^{*b})$ of the estimator, $\hat{\theta} = S(x)$ of the population parameter (θ). The bootstrap standard error is $se_B(\hat{\theta}) = [1/B \sum_1^B \hat{\theta}^*(b) - \hat{\theta}]$. Singh (1981) proved that when $n \to \infty$, the bootstrap distribution of $\hat{\theta}^*(b) - \hat{\theta}$ also follows the distribution of $\hat{\theta} - \theta$. The bootstrap 100(1-) confidence interval for $\hat{\theta}$ can be written as $[t_{b,\alpha/2} \times se_b(\hat{\theta}) < \hat{\theta} < t_{b,1-\alpha/2} \times se_b(\hat{\theta})]$.

Table (4.3) summarizes the bootstrapping results of the regression model in equation (4.2). Fifty (50) bootstrap samples are generated randomly to estimate the equation (4.1) regression model, and each sample has 6,000 data points.

The bootstrap statistics show that all the coefficients estimated from equation (4.2) are statistically significant except the state tax, revenue limit, and governor affiliation. Thus, no substantial anomalies are found between classical inference and the bootstrap inference. Therefore, the bootstrap method validates most of the fixed effect (LSDV) estimation results without any normality assumption in error terms.

4.4 Discussion and Conclusion

The main findings of the empirical study are that yields on municipal general obligation bonds in the primary market are responsive to fiscal institutions, political institutions, and shocks to the economy of a borrowing state. By charging lower interest rates, the municipal bond market rewards states that have prudent fiscal budget management and stronger antideficit, balanced budget rules. In addition, states that are ruled by fiscally conservative political forces are also rewarded with lower borrowing costs. Two important economic variables, debt and pension funding ratio, are identified as impactful in the municipal bond market.

This macroeconomic model shows that spread between the borrowing cost of a state and the risk-free rate is a function of the default probability (PD) of the state government and loss given default (LGD) for investors. In this macroeconomic model framework, the probability of default is determined simultaneously by the intertemporal utility maximization behaviors of investors (consumers) and the ability of a state government to maintain its budget constraints. In theory, the factors identified and discussed by the model account for the exogenous shocks to a state government′s finance, which influence its default probability. These factors are fiscal institutions, political institutions, and state economy.

General obligation municipal bonds show a substantial variation in bond-specific characteristics, such as issue size, maturity, call option, third-party insurance, credit ratings, state taxation, and offer method (negotiated versus competitive bids), etc. This study finds a statistically significant risk premium for every bond-specific factor, except state tax. A bond that has a larger issue size, a higher credit rating, and is covered by third-party insurance, or is offered by negotiation instead of competitive bids, is priced higher (offers lower yield) in the primary market. On the other hand, if the bond has a call option, it is priced lower (offers a higher yield) in the primary market. This study reveals that the primary market for general obligation bonds is also segmented among short-, medium-, and long-term maturities. Bonds of short-term (1-5 years) and medium-term maturities (6-12 years) offer on average 1.39% and 1.20% lower yields, respectively, than bonds of long-term maturities (Table 4.2). These findings support the arguments of Rosenbloom (1976) as well as Kidwell and Koch (1983). The results have potential implications for the fiscal management of a state. In normal economic conditions, unless fiscal authorities expect a drastic up or down movement of future market interest rates, they could keep borrowing costs lower by issuing short- or medium-term bonds and foregoing the call option right. Attracting a third-party insurer to insure the debt payment in case of default could also lower the borrowing cost. One future extension of this research would be to examine the influence of the expected movements of future risk-free interest rates (treasury yield curve) to the risk premium for bonds with longer maturity and a call option. The hierarchical linear model could provide a very useful methodology for this research.

This study estimates that states that have stronger antideficit rules also have lower borrowing costs. It also finds that states with legislative and constitutional limits on fiscal expenditures and debt borrow with lower interest rates in the primary market. These findings confirm the arguments of Poterba and Rueben (1999). Future research might examine whether antideficit fiscal rules are counterproductive during business downturns, when states cannot increase fiscal expenditures to fight recessions. As a result, the inability of states to conduct countercyclical fiscal policies may prolong the lengths of recessions. The municipal bond market, then, could price these fiscal institutions negatively during recessions.

The municipal bond market rewards states with lower borrowing costs if they are governed by fiscally conservative forces. This empirical study finds that the municipal bond market reduces interest rates for a state if majority members of the senate and house are affiliated with the Republican Party, and it punishes a state with a larger senate and house. In addition, the municipal bond prices union density in a state adversely by charging a higher interest rate. Therefore, the market appears to consider organized labor a threat to fiscal conservativeness.

Among the state economic variables that carry shocks to state public finance, unemployed labor force, home price index, and public pension funding ratio emerge as statistically significant. Among them, public pension funding ratio is positively priced, thus substantiating present market concerns about U.S. states′ public pension systems. The municipal bond market lowers borrowing cost for those states that have a better pension funding ratio (actuarial asset / actuarial liability). The existing debt of a state is priced significantly in the municipal bond market; it is one of the most important adverse economic shocks to the default probability of a state government. The higher coefficient′s value for the debt variable substantiates the argument that debt impacts the borrowing cost of a state in two ways. First, higher debt increases default probability, as does the borrowing cost. Second, increasing the borrowing cost also worsens the financial situation of a state and further increases its default probability.

Finally, the bootstrap model validation techniques validate the statistical significances of the municipal bond pricing model (equation 4.1) by repeating the fixed effect estimations on 50 samples. This technique substantiates the hypothesis that most of the estimated parameters for the model are stable, robust, and significant.

Table 4.1. Bond Factors, Fiscal Institutions, Political Institutions, and State Economic Variables on Municipal Bond Yields.

Name of Variable	Description of Variable
muniyield(n):	Yield to maturity per year of a municipal bond with n year maturity
treasyield(n):	Yield to maturity per year of a treasury bond with n year maturity
issue size:	Logarithmic value of issue amount of a municipal bond
call option:	1 if there is an call option for a municipal bond
insurance:	1 if i-th municipal bond is insured by a third party
state tax :	1 if there is state tax on interest income of a municipal
negotiation:	1 if a municipal bond is offered by negotiation, not competitive bids
credit rating:	Credit rating of a municipal bond
short:	1 if maturity of a bond is between 1-5 years
medium:	1 if maturity of a bond is between 6-12 years
maturity-short:	Maturity of a bond if it has a shorter maturity
maturity-medium:	Maturity of a bond if it has a medium maturity
ACIR:	Balanced budget rules index value for a state at year t, ranges from 0 to 10
debt limit:	1 if a state has a limit to issue general obligation bonds
expenditure limit:	1 if a state has a limit for expenditure
revenue limit:	1 if a state has a limit for tax
governor affiliation:	1 if governor of a state is Republican
senate affiliation:	1 if majority senators are Republican
house affiliation:	1 if majority house members are Republican
split legislature:	1 if senate and house are ruled by two different parties
legislative size:	Number of senate and house members together in a state
union density:	Percentage of nonagricultural wage and salary workers who are union members
unemployment:	Unemployment rate in percentage of total labor force of a state
HPI:	Both residential and non-residential home price index of a state
deficit/income:	Amount of deficit budget for a state divided by personal income of a state
debt/income:	Outstanding debt of a state divided by personal income of a state
pension fund:	Actuary funding ratio of a state's public pensions

Table 4.2. Fixed Effect (LSDV) Regressions Results for Bond Factors, Fiscal Institutions, Political Institutions, and State Economy on Municipal Bond Yields.

	Full Sample		Short Maturity		Medium Maturity		Long Maturity	
Variables	Co-efficient	t-stat*	Co-efficient	t-stat	Co-efficient	t-stat	Co-efficient	t-stat
treasury	0.573	92.43	0.583	63.66	0.414	34.02	0.317	17.43
negotiate	-0.146	-16.88	-0.146	-8.72	-0.164	-13.2	-0.122	-8.37
creditrating	0.035	8.82	0.014	1.44	0.013	2.54	0.008	1.23
lnissusize	-0.032	-8.34	-0.026	-3.93	-0.043	-7.13	-0.031	-4.57
option	0.118	5.48	-0.083	-0.87	0.023	1.65	0.275	4.16
statetax	0.03	1.69	-0.17	-0.30	0.49	1.45	-0.042	-1.79
insurance	-0.121	-14.86	-0.080	-3.12	-0.076	-5.87	-0.106	-10.98
smat	-1.170	-35.68		–	–	–	–	–
mmat	-0.974	-18.63		–	–	–	–	–
shortmat	0.087	17.11		–	–	–	–	–
medmat	0.067	16.10		–	–	–	–	–
maturity	-	-	0.082	16.04	0.093	24.61	0.035	25.94
ACIR	-0.006	-4.12	-0.006	-2.16	-0.006	-2.83	-0.007	-2.76
spendlt	-0.044	-6.73	-0.067	-4.82	-0.029	-3.29	-0.016	-1.35
revlt	-0.007	-0.52	-0.055	-2.30	-0.003	-0.13	-0.048	-2.51
debtlt	-0.018	-2.40	-0.013	-0.78	-0.012	-1.14	-0.004	0.37
govnaffil	0.008	1.05	-0.044	-2.27	0.018	1.67	0.054	5.03
senateaffil	-0.129	-10.82	-0.070	-2.99	-0.141	-7.95	-0.167	-8.33
houseaffil	-0.028	-2.42	-0.004	-0.19	-0.023	-1.4	-0.130	-5.12
splitlegis	0.039	4.49	-0.003	-0.18	0.036	3.13	0.054	3.22
size_legislation	0.148	5.40	0.095	1.70	-0.003	-0.06	-0.049	-1.25
uniondensity	0.062	17.12	0.030	4.04	0.053	10.28	0.072	12.25
unemployment	-0.008	-1.84	-0.064	-6.75	-0.058	-9.02	0.013	1.81
debt/income	0.015	3.34	0.009	0.81	-0.002	-0.38	-0.003	-0.42
deficit/income	0.002	2.15	-0.001	-0.21	0.003	1.74	0.006	3.2
Home Price	-0.001	-8.82	0.000	1.74	-0.001	-7.11	-0.002	-16.66
pension fund	-0.002	-2.36	0.000	0.04	0.000	-0.12	-0.001	-0.9
intercept	-18.76	-4.90	-12.350	-1.57	2.330	0.39	9.514	1.73

Table 4.3. Bootstrapping for Bond Factors, Fiscal Institutions, Political Institutions, and State Economy on Municipal Bond Yields.

		Classical Inference		Boot Straping	
Covariates	Coeffcient	Std. Error	t-Stat	Std. Error	Z-Stat
treasury	0.573	0.006	92.43	0.005	108.65
negotiate	-0.146	0.009	-16.88	0.009	-15.67
creditrating	0.035	0.004	8.82	0.004	9.24
lnissusize	-0.032	0.004	-8.34	0.004	-8.39
option	0.118	0.021	5.48	0.017	6.81
statetax	0.03	0.020	1.69	0.019	1.78
insurance	-0.121	0.008	-14.86	0.007	-17.33
smat	-1.170	0.033	-35.68	0.031	-37.65
mmat	-0.974	0.052	-18.63	0.040	-24.4
shortmat	0.087	0.005	17.11	0.006	15.4
medmat	0.067	0.004	16.1	0.003	20.04
fiscrest	-0.006	0.001	-4.12	0.002	-3.81
spendlt	-0.044	0.006	-6.73	0.006	-7.43
revlt	-0.007	0.013	-0.52	0.014	-0.48
debtlt	-0.018	0.007	-2.40	0.008	-2.55
govnaffil	0.008	0.008	1.05	0.007	1.17
senateaffil	-0.129	0.012	-10.82	0.011	-12.05
houseaffil	-0.028	0.012	-2.42	0.015	-1.91
splitlegis	0.039	0.009	4.49	0.010	3.86
size_legislation	0.148	0.027	5.4	0.031	4.8
uniondensity	0.062	0.004	17.12	0.003	18.61
unemployment	-0.008	0.004	-1.84	0.004	-2.23
debt/income	0.015	0.005	3.34	0.005	2.99
deficit/income	0.002	0.001	2.15	0.001	2.42
Home Price	-0.001	0.000	-8.82	0.000	-10.5
pension fund	-0.002	0.001	-2.36	0.001	-2.68

CHAPTER 5

EMPIRICAL ANALYSIS OF THE MACROECONOMIC MODEL-II

In the next empirical analysis, effects of state fiscal budget compositions on municipal bond yields are estimated by regressing a linear model that relates predictor variables-the state fiscal budget components to a specific response variable (the yields of general obligation bonds) after controlling the bond characteristics and fiscal institution variables. Table (5.1) summarizes these variables. The linear model is founded in equation (4.1) and is depicted as follows:

$$\begin{aligned} municipalyield_{it}(n) &= \beta_o + \beta_1 treasuryyield_{it}(n) + \sum_j \beta_{2,j} bondfactors_{it} \\ &+ \sum_j \beta_{3,j} fiscalinstitutions_{it} + \sum_j \beta_{4,j} budgetcomponents_{it} + \epsilon_{it} \end{aligned} \tag{5.1}$$

This linear model is estimated using the fixed effect or least square dummy variable (LSDV) panel data regression technique. A panel regression method is widely used to estimate a linear model in an empirical study. This technique depicts the relationship between a set of predictor variables (Xs) and a response variable (Y) when a dataset follows a given sample of individuals over time, and thus provides multiple observations on each individual in the sample (Hsiao, 2003). For a linear relationship, the equation for least square dummy variable (LSDV) panel data regression technique can be:

$$Y_{it} = \sum_{i=1}^{N} \alpha_i E_i + \sum_{t=1}^{T} \gamma_t T_t + \beta_1 X_{it,1} + \beta_2 X_{it,2} + ... + \beta_p X_{it,p} + \epsilon_{it} \tag{5.2}$$

where αs and γs are the coefficients for 'N' cross section and 'T' time dummies that mimic the individual and time effects in panel regression. βs are coefficients of predictor variables and ϵ is the disturbance term. If X is the $(n * p)$ matrix of predictor variables with n observations, then the regression model can be written as a vector form: $Y = X\beta + \epsilon$, where Y and ϵ are the $(n * 1)$ vectors of the response variable and the disturbances, respectively, and β is the $(p * 1)$ vector of coefficients.

The LSDV method uses the ordinary least square (OLS) technique that minimizes the $\sum(\epsilon^2)$ with respect to β, and finds an estimator ofβ: $\hat{\beta}$=$(XX')^{-1}X'Y$. The estimated $\hat{\beta}$ is considered the best linear unbiased estimator (BLUE); its variance, $var(\hat{\beta})$=$\sigma^2(XX')^{-1}$ is the lowest, and it is unbiased among the all linear estimators of β provided that X matrix has the full rank. In addition, this estimator of β is also the Maximum Likelihood Estimator (MLE) and is the most efficient among all the estimators of β as long as disturbances are normally distributed with zero mean and constant variance, $\epsilon{\sim}N(0, \sigma^2 I_n)$.

5.1 Budget Components, Bond Characteristics, and Institutions

Since the default risk of a borrowing state rises from the inability of that state to manage its primary budget deficit and to service its existing debt, it is important for the municipal bond market to understand the sources of the budget deficit, i.e., different components of revenue and expenditure. A careful analysis of different components of revenue and expenditure may reveal whether a state prudently manages its expenditures on current operations, welfare payments, capital goods, etc., and/or if this state maximizes its revenues from sources that do not jeopardize economic growth. Consequently, this study expects to find that the municipal bond market rewards a state that maintains a pro-growth and balanced budget with a lower borrowing cost and punishes a state that does the opposite, because the municipal bond market is responsible for pricing the default risk of a borrowing state and disciplines a fiscally irresponsible state with a higher borrowing cost.

Table (5.1) summarizes all fiscal budget variables along with other control variables. Yearly data of fiscal budgets$'$ variables, i.e., both total revenue and expenditure and their subcomponents, for each of the 37 states are collected from the U.S. census bureau. Total revenue (totalrev) includes all the money a state government receives from external sources during a fiscal year, net of refunds and other correcting transactions, and excludes debt issuance, investment liquidation, or as agency transactions. Total expenditure (totalexp) includes all the money paid out by a government, net of recoveries and other correcting transactions, other than for retirement of debt, investment in securities, extension of credit, or as agency transactions (www.census.govt). These two fiscal budget variables are broken down in order to examine whether various subcomponents of total revenue and total expenditure also have similar effects of total revenue and total expenditure, respectively, on a state$'$s borrowing cost. The revenue and expenditure of each state is broken down as follows:

total revenue= tax revenue + intergovernmental revenue + other revenue

total expenditure= current expenditure + capital expenditure + other expenditure

Tax revenue (taxrev) is defined as all the money a state receives during a year from the public by imposing taxes and license fees that exclude employer and employee contributions for retirements and social insurance purposes. The variable intergovernmental revenue (intgovtrev) is defined as all the money a state receives during a year from other governments as fiscal aids and grants. Other revenue (otherrev) is defined as all the money a state receives during a year except tax and intergovernmental revenues.

Capital expenditure (capitalexp) is all expenditures a state makes during a year for capital goods, such as construction or purchase of buildings, lands, and equipment. Current operation (currentop) is the direct expenditure for salary and benefits for officers and employees, and for supplies, materials, operating leases, etc. Other expenditure (otherexp) is defined as all expenditures except expenditures for current operation and capital outlay. These expenditures include intergovernmental expenditure, insurance and benefit repayment, assistance and subsidies, and interest payment for debt. Primary surplus (primarysurplus) is the fiscal surplus or deficit of a state before interest payment for debt (www.census.govt).

All the state budget variables in this study are standardized by dividing these variables by state personal income. This study expects to estimate a robust and statistically significant risk premium for each budget variable.

Table (5.2) summarizes the estimated fixed effect (LSDV) regression results that regress yields on municipal bonds against bond characteristics, fiscal institutions, and fiscal budget variables, i.e., total revenue and expenditure, as well as the components of these two variables, for the full sample, as well as the short, the medium and the long maturity sample. These fixed effect estimations also calculate robust standard error in order to control the presence of heteroskedasticity in error terms. In table (5.2), for the full sample, the estimated results provide a good fit between the data and the actual municipal bond yields. The R-square value (0.88) shows that the model predicts 88% variation in yields on municipal bonds. The coefficients for all explanatory variables are statistically significant and robust. The coefficient of the treasury variable is 0.57, which means this model predicts a 43% tax rate for marginal investors of municipal bonds. The coefficients for all bond factor variables are statistically significant and stable in the full sample, and with some reasonable exceptions, also in the other three short, medium, and long maturity samples. It is clear that the signs and strengths of coefficients, as well as the statistical significances of all bond factor variables, remain unchanged across the maturity groups (stable), except the option, credit rating, and state tax variables. The option dummy variable has a statistically significant coefficients for the full sample, medium, and long maturity samples, but a statistically insignificant coefficients for the short maturity sample. For a short maturity bond, there is not much interest rate risk for investors if a call option exists. This result makes good sense because in general, a call option is important for a bond that has a short maturity. A short maturity bond does not usually suffer with interest rate fluctuations, and in most cases, does not possess a call option. The credit rating variable is statistically significant and has expected positive signs for the full sample and short and medium maturity samples, but signs of the coefficient change for the long maturity sample. In addition, state tax is statistically insignificant for all samples except long maturity.

In addition, the coefficients of all fiscal institution variables are statistically significant and stable in the full sample, but the signs and magnitudes of all fiscal variables are not stable across different maturity-based samples. The coefficient of the ACIR (the balanced budget rules index) is statistically significant in the full sample but insignificant for the short, medium, and long maturity samples. Only the coefficient of expenditure limit is statistically significant and stable across the full and all three maturity samples. The negative coefficient values of the ACIR and expenditure variables substantiate that the municipal bond market rewards a state with a lower borrowing cost because of the state′s fiscal institutions. The coefficient of debt limit is also statistically significant and stable for all samples except the shorter and medium maturity sample, and carries a positive value. This positive coefficient value of debt limit means that the municipal bond market demands a risk premium from a state that has the constitutional limits to issue long-term general obligation bonds. This risk premium is the highest and most robust for the longer maturity sample. The revenue limit fiscal institution variable is statistically significant for the full sample, medium, and longer maturity samples, and has positive sign. The municipal bond market demands a risk premium from a state that has constitutional limits to increase revenue and to issue new debt.

The coefficients for budget variables, both total revenue and total expenditure, are statistically significant for the full sample but not for all three maturity groups. Among the three maturity samples, only the long maturity sample generates statistically significant coefficient for total revenue variables, and the long and medium maturity samples generate statistically significant coefficients for the total expenditure variable. These results show that the municipal bond market as a whole and the longer maturity bond market price total revenue positively by lowering borrowing costs for states. These negative risk premiums are 0.01% for the full sample and the long maturity sample, for 1% additional total revenue/personal income. In contrast, the municipal bond market prices the total expenditure negatively by increasing the borrowing cost for states. These positive risk premiums are 0.01% for the full sample and 0.01% for both the medium and long maturity samples, for 1% additional total expenditure/personal income.

In Table (5.3), an increase of tax revenue and intergovernmental revenue is significantly associated with lower municipal bond yields, but the other revenue has an insignificant coefficient. Particularly, the coefficient of tax revenue has the highest absolute value among all the coefficients estimated in the fixed effect regression. A 1% additional tax revenue for a state lowers its borrowing cost by 0.03%, and a 1% additional intergovernmental revenue for a state lowers its borrowing cost by 0.01%. Among these three revenue variables, tax revenue has significant and negative coefficients for the full and all three maturity samples. Intergovernmental revenue has significant and negative coefficients for the full and only the medium and long maturity samples. Similarly, current operational and other expenditures are significantly associated with higher municipal bond yields and the relationships are stable in the full and all three maturity samples. Capital expenditure is not significant for the medium maturity sample. Among the three types of expenditure variables, capital expenditure variable has the highest impact on municipal bond yields. A 1% additional current, capital, and other expenditure for a state increases its borrowing cost by 0.01%, 0.03%, and 0.02%, respectively. Among the three types of expenditure variables, current expenditure has significant coefficients for the full and all three maturity samples, but sign changes from positive to negative for the short maturity sample. Other expenditure has significant and positive coefficients for the full and only the medium and long maturity samples. Finally, capital expenditure has significant and positive coefficients for the full and short and long maturity samples.

In summary, these results suggest that the municipal bond market discounts the revenues sources and expenditure purposes of state budgets vigilantly, and disciplines or rewards states based on their fiscal management.

5.2 Model Diagnostic Test

Although this study successfully developed a regression model based on bond characteristics, fiscal institutions, political institutions, and state economic variables, and fit the data with a 88% R-square value, it is essential to diagnose the BLUE properties of the estimator of the coefficients. One starting point would be to estimate the multicollinearity among the independent variables, i.e., estimating the Variance Inflation Factor (VIF). Any VIF value greater than 10 would be an indicator of higher correlation among the independent variables. From the regression model of equation (5.1), the mean VIF score for all regressors is calculated to be 4.72. Overall, it can be safely inferred that linear dependence among regressors in this model is negligible, and the estimators of the coefficients for this regression model retained the BLUE property.

Three F-tests examine whether all bond character factors, all fiscal institutions, and all budget variables are blockwise jointly zero. These F-tests show that the coefficients for all groups are block wise jointly nonzero (p-value less than 1%). Thus, the presence of these three groups of variables in the regression model is justified, and no risk factors should be dropped from the regression model, even if any factor is statistically insignificant based on an individual t-test.

Next, the assumption of normality of the error term could be another property to examine for the regression model. The assumption that errors of the regression model follow normal distribution, $\epsilon \sim N(0, \sigma^2 I_n)$, is essential for the estimators of the coefficients to be the most efficient estimators among all classes of estimators. A standard Jarque-Bera test for normality of error term is used for this study to examine the validity of the above-mentioned assumption. For this regression model, the JB statistic is calculated as 354248. The chi-square critical value at the 5% level of significance and 2 degrees of freedom is 5.99. Thus, the null hypothesis of normality is rejected. Since the regression model generated nonnormal error terms, the estimators of the coefficients for this regression model may not be the most efficient. Thus, t-statistics calculated for statistical inference should be accepted with caution.

5.3 Model Validation

Model validation refers to finding the correct model, stability, and robustness of estimators of the regression coefficients as well as the plausibility and usability of the regression function for prediction and ability to generate inferences drawn from the regression function (Oredein et al., 2011). Snee (1977) emphasized the model validation by arguing that data collected without the aid of an experimental design may have several defects. Both the dependent and independent variables may contain errors, both types of variables may not have sufficient variations, and important variables may be missing. Thus, some type of validation should be made before using any model for prediction. There are several methods for model validation, e.g., cross validation, bootstrapping, etc. Each validation model has advantages and disadvantages. Oredein et al. (2011) estimated several model validation techniques for a regression model and found that bootstrapping provides the minimum prediction errors. Bootstrapping avoids any assumption of the distribution for a population or for an estimated population parameter. The bootstrap method selects B number of independent bootstrap samples $(X^{*1}, X^{*2}, ...X^{*b})$ of size n drawn from the original sample (F) with replacement: $X^* = (x_1^*, x_2^*, x_3^*, ...x_n^*)$; $F = (x_1, x_2, x_3, ...x_n)$, where star sign (*) indicates X^* is a re-sample version of X. Then it calculates the bootstrap replication $\hat{\theta}^* = (\hat{\theta}^{*1}, \hat{\theta}^{*2}, \hat{\theta}^{*3}, ...\hat{\theta}^{*b})$ of the estimator, $\hat{\theta} = S(x)$ of the population parameter (θ). The bootstrap standard error is $se_B(\hat{\theta}) = [1/B \sum_1^B \hat{\theta}^*(b) - \hat{\theta}]$. Singh (1981) proved that when $n \to \infty$, the bootstrap distribution of $\hat{\theta}^*(b) - \hat{\theta}$ also follows the distribution of $\hat{\theta} - \theta$. The bootstrap 100(1-) confidence interval for $\hat{\theta}$ can be written as $[t_{b,\alpha/2} \times se_b(\hat{\theta}) < \hat{\theta} < t_{b,1-\alpha/2} \times se_b(\hat{\theta})]$.

Table (5.4) summarizes the bootstrapping results of the regression model in equation (5.1). Fifty(50) bootstrap samples are generated randomly to estimate the equation (5.1) regression model, and each sample has 6,000 data points.

The bootstrap statistics show that all of the coefficients estimated from equation (5.1) are statistically significant except the state tax, revenue limit, the ACIR index, and Other revenue. Thus, no substantial anomalies are found between classical inference and the boot-strap inference. Therefore, the bootstrap method validates most of the fixed effect (LSDV) estimation results without any normality assumption in error terms.

5.4 Conclusion and Discussion

The main findings of this study are that yields on municipal general obligation bonds in the primary market are responsive to fiscal institutions and the fiscal budget management of a borrowing state. By charging lower interest rates, the municipal bond primary market rewards states that have prudent fiscal budget management and stronger antideficit, balanced budget rules. This study estimates a municipal general bond pricing model by analyzing 17,400 general obligations bonds issued in the primary market.

The macroeconomic model shows that spread between the borrowing cost of a state and the risk-free rate is a function of the default probability (PD) of the state government and loss given default (LGD) for investors. In this macroeconomic model framework, the probability of default is determined simultaneously by the intertemporal utility maximization behaviors of investors (consumers) and the ability of a state government to maintain its budget constraints. In theory, the factors identified and discussed by the model account for the exogenous shocks to a state government′s finance, which influences its default probability. These risk factor categories could be bond-specific factors, fiscal antideficit institutions, and fiscal budget management.

General obligation municipal bonds show a substantial variation in bond-specific characteristics, such as maturity, call option, third-party insurance, credit ratings, state taxation, and offer method (negotiated versus competitive bids), etc. This study finds a statistically significant risk premium for every bond-specific factor. A bond that has a higher credit rating, is covered by third-party insurance, and is offered by negotiation instead of competitive bids, is priced higher (offers lower yield) in the primary market. On the other hand, if the interest income of a bond is subject to state tax and/or it has an option call, it is priced lower (offers a higher yield) in the primary market. This study also reveals that the primary market for general obligation bonds is also segmented among short-, medium-, and long-term maturities. Bonds of short-term (1-5 years) and medium-term maturities (6-12 years) offer on average 1.39% and 1.20% lower yields, respectively, than bonds of long-term maturities (Table 5.2). These findings also support the arguments of Rosenbloom (1976) as well as Kidwell and Koch (1983). The results have potential implications for the fiscal management of a state. In normal economic conditions, unless fiscal authorities expect a drastic up or down movement of future market interest rates-they could keep borrowing costs lower by issuing short- or medium-term bonds and foregoing call option right. Attracting a third-party insurer to insure the debt payment in case of default could also lower the borrowing cost. One future extension of this research would be to examine the influence of the expected movements of future interest rates (yield curve) to the risk premium for the longer maturity and for the presence of call option. The hierarchical linear model could provide a very useful methodology for this research.

Except for Vermont, each state has a balanced budget requirement, but the stringency of these requirements varies widely. In addition, many states have legislative and/or constitutional limits on expenditure, revenue/tax imposition, and debt level. This study estimates that states that have stronger antideficit rules also have lower borrowing costs (0.01%). This study also finds that states that have legislative and constitutional limits on fiscal expenditures borrow with 0.8% lower interest rates in the primary market. These findings confirm the arguments of Poterba and Rueben (1999). Another interesting result is that the municipal bond market actually penalizes states that have a debt limit with a higher borrowing cost (0.02%). Future research might examine whether antideficit fiscal rules are counterproductive during business downturns, when states cannot increase fiscal expenditures to fight recessions. As a result, states′ inability to conduct countercyclical fiscal policies may prolong the lengths of recessions. The municipal bond market, then, could price these fiscal institutions negatively during recessions.

Since the default risk of a borrowing state rises with the inability of that state to manage its primary budget deficit and to service its existing debt, investors in the municipal bond market need to judge the sources of the budget deficit (i.e., different components of revenue and expenditure). Yields on municipal bonds should reflect their judgments. This study reports that the primary market for general obligation bonds prices the revenue and the expenditure management of a borrowing state. Borrowing states that have higher tax revenues and receive higher intergovernmental revenues pay lower interest rates. Similarly, borrowing states that have higher current operational expenditures (larger size of governments) and higher expenditures for welfare, subsidy, etc., pay higher interest rates in the primary market. These findings reveal important information about relationships between fiscal budget management and borrowing cost in the municipal bond market. The municipal bond market heavily prices tax revenue, which is almost 68% of a state′s income. It demands 0.01% lower borrowing costs for 1% of additional tax revenue. Surprisingly, however, the municipal bond market also demands 0.03% lower borrowing costs for 1% additional federal money transferred to states. This intergovernmental revenue consists of 22% of a state′s fiscal revenue. This finding emphasizes the size and importance of federal money for states.

Finally, Bootstrap model validation techniques validate the statistical significance of the municipal bond pricing model (equation 5.1) by repeating the fixed effect (LSDV) estimations on 50 samples, without assuming any normally distributed error terms. The boot strap techniques substantiate that the estimated parameters from the model are stable, robust, and significant.

Table 5.1. Bond Factors, Fiscal institutions, Budget Component Variables.

Name of Variable	Description of Variable
muniyield(n):	yield to maturity per year of a municipal bond with n year maturity
treasyield(n):	yield to maturity per year of a treasury bond with n year maturity
issue size:	logarithmic value of issue amount of a municipal bond
call option:	1 if there is a call option for a municipal bond
insurance:	1 if i-th municipal bond is insured by a third party
state tax :	1 if there is state tax on interest income of a municipal
negotiation:	1 if a municipal bond is offered by negotiation, not competitive bids
credit rating:	credit rating of a municipal bond
short:	1 if maturity of a bond is between 1-5 years
medium	1 if maturity of a bond is between 6-12 years
maturity-short	Maturity of a bond if it has a shorter maturity
maturity-medium	Maturity of a bond if it has a medium maturity
ACIR:	Balanced budget rules index value for a state at year t, ranges from 0 to 10
debt limit:	1 if a state has a limit to issue general obligation bonds
expenditure limit:	1 if a state has a limit for expenditure
revenue limit:	1 if a state has a limit for tax
totalrev:	Total revenue/personal income collected by a state
taxrev:	Tax revenue/personal income collected by a state
intgovtrev:	Intergovernmental revenue /personal income received by a state
otherrev:	All other revenues/personal income collected by a state
totalexp:	Spending for current operation/personal income by a state
currentexp:	Spending for capital outlay/personal income by a state
capitalexp:	Other spending/personal income by a state
otherexp:	Fiscal surplus or deficit before interest payment /personal income for a state

Table 5.2. Fixed Effect (LSDV) Regressions Results for Bond Factors, Fiscal Institutions, and Fiscal Budgets on Municipal Bond Yields.

	Full Sample		Short Maturity		Medium Maturity		Long Maturity	
Variables	Co-efficient	t-stat	Co-efficient	t-stat	Co-efficient	t-stat	Co-efficient	t-stat
treasyield	0.57	162.01	0.64	139.6	0.52	88.21	0.36	36.66
negotiate	-0.13	-15.44	-0.11	-7.42	-0.13	-11.06	-0.08	-5.31
credit rating	0.06	17.03	0.06	7.6	0.05	11.19	-0.01	-1.43
lnissuesize	-0.03	-7.17	-0.02	-3.7	-0.04	-7.24	-0.02	-2.76
option	0.11	5.46	0.03	0.72	0.03	1.98	0.24	3.61
statetax	-0.01	-0.45	0	0.09	0.02	0.78	-0.12	-4.19
insurance	-0.14	-16.63	-0.08	-2.79	-0.08	-6.44	-0.15	-14.36
short	-1.3	-43.86	–	–	–	–	–	–
shortmat	-1.12	-22.75	–	–	–	–	–	–
medium	0.1	20.61	–	–	–	–	–	–
mediummat	0.08	19.83	–	–	–	–	–	–
maturity	–	–	0.08	15.81	0.09	27.35	0.03	25.13
ACIR	-0.01	-2.46	-0.01	-0.64	-0.01	-1.73	0.01	1.15
Expendlimit	-0.07	-10.79	-0.07	-5.22	-0.04	-4.84	-0.09	-8.98
Revlimit	0.03	2.96	-0.04	-1.91	0.02	1.32	0.06	3.28
Debtlimit	0.02	3.43	0	0.17	0.02	2.45	0.03	2.7
Totalrev	-0.01	-2.68	0.01	1.53	-0.01	-0.34	-0.01	-5.01
Totalexp	0.01	4.92	-0.01	-0.52	0.01	2.84	0.01	6.64
intercept	2.11	25.58	0.59	4.87	1.28	10.74	2.36	13.52

Table 5.3. Fixed Effect (LSDV) Regressions Results for Bond Factors, Fiscal Institutions, and Decomposed Fiscal Budgets on Municipal Bond Yields.

	Full Sample		Short Maturity		Medium Maturity		Long Maturity	
	Co-efficient	t-stat	Co-efficient	t-stat	Co-efficient	t-stat	Co-efficient	t-stat
treasyield	0.57	157.72	0.63	131.04	0.52	85.35	0.37	36.85
negotiate	-0.13	-15.74	-0.11	-7.28	-0.13	-10.9	-0.09	-6.09
credit rating	0.06	16.98	0.06	8.39	0.05	10.99	0.01	-0.62
lnissuesize	-0.03	-7.26	-0.02	-3.66	-0.04	-6.98	-0.03	-3.51
option	0.11	5.45	0.03	0.68	0.03	1.89	0.25	3.65
statetax	-0.01	-0.26	0.02	0.34	0.04	1.13	-0.11	-4.01
insurance	-0.13	-16.06	-0.06	-2.22	-0.07	-5.63	-0.15	-14.35
short	-1.3	-43.87	–	–	–	–	–	–
medium	-1.12	-22.84	–	–	–	–	–	–
shortmat	0.1	20.55	–	–	–	–	–	–
mediummat	0.08	19.94	–	–	–	–	–	–
maturity	–	–	0.08	16.38	0.01	27.65	0.03	25.24
ACIR	0.01	-0.57	0.01	0.51	0.61	0.14	0.01	1.95
expendlimit	-0.08	-12.28	-0.07	-5.23	-0.01	-5.48	-0.1	-10.12
revlimit	0.03	2.57	-0.04	-1.83	0.07	0.22	0.07	3.45
debtlimit	0.02	2.37	-0.01	-0.38	0.7	0.66	0.02	2.29
taxrev	-0.01	-13.45	-0.01	-2.53	0.01	-9.45	-0.05	-12.4
intgovtrev	-0.03	-4.09	-0.01	0.86	-0.39	-5.59	-0.02	-4.58
otherrev	0.01	1.26	0.01	1.98	0.05	4.53	-0.01	-2.53
currentexp	0.01	5.15	-0.01	-3.31	0.01	4.71	0.02	8.14
capitalexp	0.03	3.26	0.06	3.08	0.01	0.12	0.05	4.29
otherexp	0.02	10.13	0.02	4.78	0.01	8.82	0.02	5.94
intercept	2.1	25.03	0.5	4.11	1.25	10.47	2.48	13.68

Table 5.4. Bootstrapping for Bond Factors, Fiscal Institutions and Fiscal Budgets on Municipal Bond Yields.

		Classical Inference		Bootstrap Inference	
	Co-efficients	Std. error	t-stat	Std. error	z-stat
treasyield	0.57	0.004	157.72	0.007	86.71
negotiate	-0.13	0.008	-15.74	0.013	-9.69
credit rating	0.06	0.004	16.98	0.007	8.33
lnissuesize	-0.03	0.004	-7.26	0.006	-4.32
option	0.11	0.02	5.45	0.037	3
statetax	-0.01	0.021	-0.26	0.03	-0.18
insurance	-0.13	0.008	-16.06	0.015	-9.04
short	-1.3	0.03	-43.87	0.052	-24.97
medium	-1.12	0.049	-22.84	0.084	-13.33
shortmat	0.1	0.005	20.55	0.009	11.16
mediummat	0.08	0.004	19.94	0.006	12.11
ACIR	0.007	0.001	-0.57	0.002	-0.43
expendlimit	-0.08	0.006	-12.28	0.011	-7.13
revlimit	0.03	0.011	2.57	0.018	1.6
debtlimit	0.02	0.007	2.37	0.012	1.36
intgovtrev	-0.03	0.002	-13.45	0.004	-7.11
Tax rev	-0.01	0.002	-4.09	0.004	-2.27
otherrev	0.002	0.001	1.26	0.002	0.93
currentexp	0.01	0.002	5.15	0.002	3.85
capitalexp	0.03	0.008	3.26	0.013	2.08
otherexp	0.02	0.002	10.13	0.004	5.58

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